Monitor National Marine Sanctuary
National Marine Sanctuary System

- Olympic Coast
- Greater Farallones
- Cordell Bank
- Papahānaumokuākea
- Hawaiian Islands Humpback Whale
- Monterey Bay
- Channel Islands
- American Samoa (U.S.) (Including Rose Atoll)
- Wisconsin - Lake Michigan
- Thunder Bay
- Stellwagen Bank
- Mallows Bay - Potomac River
- Monitor
- Gray’s Reef
- Florida Keys
- Flower Garden Banks

Scale varies in this perspective. Adapted from National Geographic Maps.
Curriculum and More

• Overview of the Monitor NMS and Maritime Heritage Program

• *Shipwreck of the Deep*—Integrated curriculum developed in partnership with Newport News Public Schools

• *Maritime Archaeology: Discovering and Exploring Shipwrecks*—A guide integrated with social studies and STEM

• Other Educational Offerings—A variety of standalone activities and learning modules from Civil War to WWI
What was the USS Monitor?

An Innovative Warship Built in less than 100 Days
Inventor and Innovator

• John Ericsson

• Innovative Technology

• Major Impact on Maritime and Military History
USS Monitor and the CSS Virginia engage in the first battle of steam powered ironclads. The battle ushers in a new era of naval technologies and naval warfare.
John G. Newton of the Duke University Marine Laboratory proposed testing the application of geological survey equipment for underwater archaeological survey and assessment.
History and Technologies Worth Preserving
The *Monitor* National Marine Sanctuary was established by Congress on January 30, 1975, the 113th Anniversary of the *Monitor*’s launching at Greenpoint, NY.
A column of water one mile in diameter from the surface of the sea to the seafloor
Recovery and Archaeology
Once the sections of deck and armor belt were removed....

....the turret was partially excavated to reduce the lift weights.
Monitor Expedition 2002 – Turret Recovery

August 5, 2002 5:47 PM
Joint POW/MIA Accounting Command (JPAC)  
(Central Identification Laboratory)  
Hawaii
LSU FACES Lab  
(Competitive Anthropology and Computer Enhancement Services)

Mary Manhein  
Director

Nicole Del Harris  
Forensic  
Anthropologist
US Navy Memorial Museum
Washington, DC

USS Monitor
In Honor of all those who served on the USS Monitor and in Memory of the 16 officers and crew who made the ultimate sacrifice when the ship sank on Dec. 31, 1862

Presented 2012 by the Monitor National Marine Sanctuary

---
USS Monitor: Preserving a Legacy

Battle of Hampton Roads

On February 25, 1862, the USS Monitor and CSS Virginia met off the Virginia Capes. Although the CSS Virginia won the first battle, the Monitor was able to return to Hampton Roads for repairs.

The Lost Monitor Boys

On December 31, 1862, 16 men perished that morning near the CSS Virginia. Official records of the incident are incomplete. The CSS Virginia was the largest warship built in the Confederacy.

The Lost Monitor Boys

A second, larger letter went to Geer's brother, which had harrowing details of the sinking: details Geer wished to be kept to Geer's family and friends that were safe. George Geer, Geer's brother, was a sailor on the Monitor and was killed in the battle.

For Teachers

The Monitor National Marine Sanctuary aims to provide teachers with resources and training to support the 150th Anniversary of the USS Monitor. You will find curriculum, lesson plans, and activities that will excite your students not only about the Monitor and the Civil War, but also about science and technology.

Students Through Time

Students became detectives and use various sites to discover the identity of a sailor whose remains were discovered on a Civil War shipwreck.
Battle of the Atlantic
Battle of the Atlantic (1939-1945)
• Little known, but significant part of our national story
• U-Boats operated all along the Atlantic coast including the Chesapeake Bay
• North Carolina - Where the war came home
Significance of North Carolina

- Shipping Lanes
- Oceanic Currents
- Continental Shelf
- Water Depth
- Water Temperatures
U-85
Photomosaics

U-85

U-352
Battle of the Atlantic
2008 Archaeological Survey

U-85

U-352

U-701

Drawn to Scale
Technology

Multi Beam Sonar on an ROV
Multibeam Sonar Survey during which the YP-389 was located and subsequently identified.

Background on the Discovery of the YP-389
- 1973 Eastward Tie to the Monitor Multibeam sonar survey
Discovery of U-576 and Bluefields
Maritime Heritage: Shipwrecks of the Deep Project Based Learning
Crittenden Middle School

75% Black
17% White
6% Hispanic
2% Asian
1% Two or more races

68% Free or Reduced Lunch
Course Outline
Development

Two Teachers
Semester Course
Maritime Heritage
Ecology / MWEE
Crittenden Goals

Semester-length, Motivating STEM Curriculum with Ecology Service Project
Our Goals
NOAA’s Maritime Heritage Program
Integrated Curriculum

Three Sections:

- Maritime Heritage and Archaeology
- Life Science
- Chemistry of Conservation
Part I—Maritime Heritage

Project-Based

Students simulate searching for a shipwreck while learning about maritime heritage and archaeology. They use primary source documents and images to identify the shipwreck.
Students Simulating Searching for Shipwrecks and Engage in Engineering
Incorporating STEM into the Classroom

- Engineering Design
- Newton’s Laws of Motion
- Buoyancy—Archimedes Principle
- Properties of Air
- Team Work
- Math
Mock Shipwreck Mapping Activity

Mock Shipwreck: Mapping the Past

Activity Summary

Maritime archaeology is a field of study that provides many career opportunities based in science, technology, engineering, and mathematics (STEM). The focus of this lesson is the creation of a shipwreck site plan. The students engage in teamwork as “divers” to create sectional, scaled drawings of a mock shipwreck. The students make connections to maritime history, mathematics, and technology.

NOTE: Extension activities incorporate English language and social studies.

Learning Objectives

Students will be able to:
- Define maritime archaeology and describe its importance to our national maritime heritage.
- Employ measuring and scaling techniques to sketch drawings of a mock shipwreck to better understand how divers document an actual shipwreck.
- Determine the scale factor of their drawing in relation to the mock shipwreck.
- Make inferences about the mock shipwreck based on observations.

Background Information

During World War II, many battles were fought on foreign shores. However, few people know about those fought closer to home. The Battle of the Atlantic consisted of several skirmishes and decisive maneuvers between German U-boats and Allied and merchant ships all along the coasts of Europe and the United States.

The German U-boats were under orders to prevent merchant vessels from getting supplies to Allied nations. The United States deployed their own ships to act as defensive escorts armed with anti-submarine artillery. Many German and Allied merchant ships fought and sank off the North Carolina and Virginia coasts.

The wrecks of these sunken ships still lie at the bottom of the ocean. It is the job of maritime archaeologists to find and study these links to our past in order to understand our history, conserve our heritage, and honor the memory of those who died defending our nation’s future.

http://sanctuaries.noaa.gov/education
Pool Time
Puzzling Pieces

Reading the Records

Sleuthing Through 1908

Purpose: To collect clues, analyze and compare them and use source documents to draw conclusions.

Materials:
- Per Group: 12 bags with artifacts and letters
- List of missing people
- Per Class: tub or small swimming pool filled with sand

Old Weather Project
Under the leadership of the University of Colorado's Zoology Program, the U.S. National Oceanic and Atmospheric Administration (NOAA), U.S. National Oceanographic and Meteorological Office and Naval-History Net are working to explain that the remains of the Monitors were discovered off the coast of Romania in 1996. In an expedition conducted by the Romanian Institute for Underwater Archaeology, a team of American and Romanian archaeologists conducted an investigation on the site and attempted to identify them against records and DNA samples. Artifacts recovered are also helping to identify the unknown.

Per Teacher:
The teacher will create 12 bags (one will be used with the tube of sand). Inside each bag, place "artifacts" that help to identify the owner of each bag. Suggested "artifacts" are listed on the artifact sheet (p. 56), but you may substitute other items that might be more readily available. Just be sure to have the stories of each person match the theme you place in the bag (e.g. if the story says that a sailor had a wife and child, then the photograph should be of a woman and a child). Search the internet for images that match information. Write letters from the imagines. (See Sample Letters, p. 86.)

To model how to use artifacts to identify unknowns, fill a large tub or small swimming pool with seawater. Make sure sand is dry and not damp. In the sand, hide the suggested "artifacts" for the group. (For example, a bottle, a coin, a key, etc.)

For each group of students, print story sheet, The Mystery of the Monitor, (p. 56) and the activity sheet with the List of Crew and Passengers (p. 67). Go through the artifacts in the tub one-by-one, and have students review the story and the list of those onboard. Come to a consensus with the group as to the identity of the remains. If you continue working independently with your group, go through the artifacts in their bag, to determine who once owned the bag.

NOTE: Be realistic, wear gloves as you handle the "artifacts."
Students build an observation buoy and learn about water quality in order to determine if the shipwreck site is a healthy artificial reef.

Then they explore oyster gardening, grow spat, and do an oyster restoration project.
Wrecks as Reefs
Growing Oyster Spat
Water Shed
Pollution
Water Quality Testing
Basic Observation Buoy (BOB)
Oysters as Filters
Plankton Tow—Identifying Plankton
Deploying and Recovering Buoy from the SRVx Sand Tiger

Grant Funded
In the last section, students learn about conservation of artifacts and ethical practices.

As a culmination of the project, students hold a Socratic seminar and give their final decision to NOAA on what to do with the shipwreck.
Artifact Recovery

August – December 2002

Monitor Collection, NOAA
Socratic Seminar

Final Presentation
Maritime Archaeology:
Discovering and Exploring Shipwrecks

NEW
Integrated Curriculum

- NOAA and MHP
- Ships through Time
- Maritime Archaeology
- Tools of Shipwreck Discovery
- Documenting Shipwrecks
- What's Next?

http://monitor.noaa.gov
PROGRAM

This curriculum introduces students to the study of archaeology and the importance of preserving our nation's marine heritage. The curriculum is designed to be used by educators in the classroom or as a resource for families and the public. The curriculum is organized into four distinct learning experiences:

1. **Objectives**: Students will:
   - Understand the history of the site and its significance.
   - Learn about the methods used in archaeological investigations.
   - Explore the role of archaeology in understanding cultural history.

2. **Vocabulary**:
   - **archaeology**: the study of human culture through the excavation of material remains and artifacts.
   - **autonomous**: able to function independently.
   - **C.L.**: cultural or historical landmark.
   - **cultural**: referring to the customs and traditions of a group or society.

3. **Web Resources**:
   - NOAA's Office of National Marine Sanctuaries: 
     - **http://oceanservice.noaa.gov/education/education.html**
   - **http://www.marinemuseum.org**
   - **http://www.nationalmuseum.com**

4. **Optional Activities**:
   - **Vocabulary Game**: Create flashcards with key terms and definitions.
   - **Historical Timeline**: Create a timeline of significant events in marine archaeology.
   - **Field Trip**: Visit a local museum or historical site.

**Educational Standards**

The following pages list an overview of educational standards for:

- National Council for Social Studies (NCSS)
- Common Core (CC)
- National Geography Standards (NGS)
- National Council of Teachers of English (NCTE)
- National Science Standards (Archived Standards from NISTA)
- Next Generation Science Standards (NGSS)
- Ocean Literacy Principles (OLP)
- National Mathematics Standards (NCTM)

This is not a comprehensive list, but includes the standards that are most prominent within the curriculum guide. The standards for each activity are listed on the first page of the activity in the blue box on the left of the bottom. See each standard for key to coding format in the activities (e.g. NCSS: US.E.S.5.9.SF for National Council of Social Studies, U.S. History, Era 5).
### Education Standards Continued

#### National Council for Social Studies
http://www.socialstudies.org

<table>
<thead>
<tr>
<th>NCSS STANDARDS:</th>
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<tbody>
<tr>
<td>Standard 1: Cultures</td>
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<td>Standard 2: Time</td>
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<td>Standard 3: People</td>
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<td>Standard 4: Places</td>
<td></td>
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<td>Standard 5: World Regions</td>
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</table>

#### National Mathematics Standards
http://www.nctm.org/

| NCTM 6-8 Numbers and Operations — Understand numbers, ways of representing numbers, relationships among numbers, and number systems (Computation, D) |  |
|—— |  |
| NCTM 6-8 Numbers and Operations — Understand numbers, ways of representing numbers, relationships among numbers, and number systems (Computation, A and B) |  |
| NCTM 6-8 Geometry — Specify locations and describe spatial relationships using coordinate geometry and other representational systems |  |
| NCTM 6-8 Measurement Standard — Understand measurable attributes of objects and the units, systems, and processes of measurement. (A, B, and C) |  |
| NCTM 3-12 Measurement Standard — Specify locations and describe spatial relationships using coordinate geometry and other representational systems (A and B) |  |
| NCTM 3-12 Geometry — Use visualization, spatial reasoning, and geometric modeling to solve problems (A, B and C) |  |
| NCTM 3-12 Process Standards — Problem solving; Connections; Representation |  |
### Activities and Worksheets

#### Section A: NOAA and Maritime Heritage

- **NOAA Who?**
  - Explore the world of NOAA on the web
  - Page 14

- **Monitor to the Rescue**
  - Explore the historical significance of the USS Monitor
  - Page 18

- **NOAA's Maritime Heritage Program**
  - Learn how NOAA helps to protect our nation's maritime heritage
  - Page 20

#### Section B: Ships through Time

- **Sailing Through the Ages**
  - Explore the advancement of ships
  - Page 24

- **Abandon Ship!**
  - Learn various reasons why ships sink
  - Page 30

- **Past Connections**
  - Understand how shipwrecks connect us to the past
  - Page 34

#### Section C: Maritime Archaeology

- **Maritime Archaeology**
  - Learn its history
  - Page 40

- **Who’s Who in Maritime Archaeology**
  - Discover the early pioneers of underwater archaeology
  - Page 49

#### Section D: Tools of Shipwreck Discovery

- **Searching the Deep Intro**
  - Overview of the tools used by maritime archaeologists
  - Page 62

- **Plotting the Course**
  - Discover the role of research
  - Page 64

- **Side Scan Sonar**
  - Understand how technology is used in searching and documenting shipwrecks
  - Page 72

#### Section E: Documenting Shipwrecks

- **ROV, AUV and Towfish**
  - Learn about necessary tools in maritime archaeology
  - Page 82

- **Scuba, Scuba, Scuba Do**
  - Discover how scuba diving was invented and the role it plays in maritime archaeology
  - Page 88

- **Magnetometers**
  - Understand how magnetometers are used
  - Page 97

- **NOAA Vessels**
  - Explore the many NOAA vessels
  - Page 101

- **I Can Name that Part**
  - Identify the parts of a ship and learn nautical terms
  - Page 106

- **Putting the Pieces Together**
  - Create a photomosaic
  - Page 110

- **Mapping the Past**
  - Simulate mapping a shipwreck
  - Page 115

#### Section F: What’s Next?

- **Historically Significant?**
  - Determine what makes a shipwreck historically significant
  - Page 136

- **Ethically Speaking**
  - Explore the ethics of shipwrecks and learn about some of the laws that protect them
  - Page 140

- **The Art of Artifacts**
  - Learn when, why and how artifacts are recovered (Analyzing Artifacts, Making Inferences, and Picking Up the Pieces)
  - Page 148

- **Conservation and Conservators**
  - Understand the complex process of conservation (Exploring Conservation of Monitor's Tunnel, Rusting Away, Changing Metal)
  - Page 155

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**http://monitor.noaa.gov**
Section A

**Exploring NOAA**

**Background**

Reside under the Department of Commerce: the National Oceanic and Atmospheric Administration.

**Monitor to the Rescue**

As our nation's first national marine sanctuary, Monitor National Marine Morine (MNNMS) was established to protect and preserve our nation's first Civil War ironclad, USS Monitor. The Monitor and her brave crew helped to turn the tide of Civil War and forever changed naval warfare when it fought the Confederate CSS Virginia, also known as the Monitor.

As the two ships fought in the Battle of Hampton Roads on March 9, 1862, relatively small ironclads with a rockit for a gun turret, the Monitor's defensive design gave her a new role: a modern warship. The Monitor became the standard for all future ironclads.

The Monitor did not see much action after the Battle of Hampton Roads. It was sent to support a small dhow at Sewall's Point and it also participated in the Battle of Drydock Point near Richmond. The crew, affectionately known as Monitor Boys, spent most of their time in Hampton Roads waiting for another battle, the CSS Virginia.

On December 31, 1862, just 11 months after it launched from Grover's Wharf, the Monitor encountered a storm off Cape Hatteras, N.C., and hit a submerged rock, which damaged her steel hull. The Monitor's crew abandoned the ship during the night, and it sank. The Monitor's remains were discovered in 1975, when John G. Newton and his team from University Marine Museum used side scan sonar to identify the remains. They identified the Monitor as the one that had been lost, and in 1976, themonitor became the nation's first national marine sanctuary.

In 2002, NOAA, in collaboration with the US Navy, raised the iconic Monitor. When the wrecks were raised, they found the remains of the Monitor. Since then, the more remains of the Monitor have been recovered. The Monitor's remains are displayed at the Mariners' Museum in Virginia Beach, Virgina.

**NOAA's Maritime Heritage Program**

**Museums of the Deep**

Class Activity

Background

America's greatest museum of our past as a seafaring nation lies on the bottom of our nation's oceans, seas, bays, and rivers. This is where they live and appreciate our country's maritime cultural heritage. That heritage is a legacy of thousands of years of settlement, exploration, immigration, and harvesting the bounty of the sea. It is an important link to our past and how we need to develop our nation. Through NOAA's dynamic education and outreach programs, exhibits, visitors' centers, and media, the importance of our unique heritage is preserved for the knowledge and development of our nation's cultural resources.

In June 2000, the president recognized the need to increase ocean exploration and thus, he established the Office of Ocean Exploration and Research (OER). The Office was created to coordinate the agency's exploration and research expeditions with the mission to enhance research, policy, and management decisions, to develop new lines of scientific inquiry and to advise NOAA and the nation on critical issues. OER works with archeologists, scientists, and oceanographers to explore the vast mysteries of our country's waterways.

Created in 2002, NOAA's Maritime Heritage Program is an initiative of the Office of National Marine Sanctuaries (ONMS). Each of our thirteen national marine sanctuaries and two marine national monuments, regardless of regulation and designation purposes, contain cultural resources. However, two sanctuaries, Monitor National Marine Morine and Thunder Bay National Marine Sanctuary, are specifically designated to protect shipwrecks. Today, through partnerships with the Office of Ocean Exploration and Research, other state and federal agencies and academies, the program continues to focus on maritime heritage resources within the National Marine Sanctuary System and promotes maritime heritage appreciation throughout our entire nation.
Sailing Through the Ages

Abandon Ship!

Background

Why do ships sink? The shipwrecks, because many shipwrecks are even intermittently often a common reason anchorage and to damage break apart or to take on water of course causing them to sink.

Other factors that make ships sink include the following:

- Lack of water, which can be a hazard
- Unknown size and does not apply
- How much weight
- How much tension
- How much warping
- How much water damage
- How much wind damage
- How much pressure
- How much weight
- How much warping
- How much water damage
- How much wind damage
- How much pressure

Another factor that caused the ship to sink:

- Many ships were sunk from unknown causes, or by unknown means, or by the means for which they were built, or by the means for which they were designed, or by the means for which they were intended, or by the means for which they were developed, or by the means for which they were constructed.

The answer to why ships sink: There is no unique story to tell. Titanic and some never mind. The story of the ship may be easy, but you need the story. The story of the ship may be easy, but you need the story. Therefore, you need to know about shipwrecks and the significance of the public.

Activity Overview

In this activity students will:

- Research a selected ancient shipwreck
- Answer key questions about the shipwreck
- Write a report using the research

Key Words

- Ancient shipwreck
- Archaeology
- Marine
- Exploring

Past Connections

Background

Humans, ships and the ocean have long been intricately bound together. Even in ancient times, ships provided the fastest and most economical means to move goods, people, and ideas from one place to another. However, the ocean can be an unforgiving place and some ships inevitably sink.

Shipwrecks offer an exciting window into the study and preservation of our past. They are a random sampling of voyages, a record of past trade and communication. It is almost as if they are frozen in time.

These submerged cultural resources give us a fresh perspective on history and are valuable classroom resources. However, sometimes it is hard to see how they relate to our lives. These activities offer insights into the history of the past.

Learning Objectives

- To describe types of shipwrecks
- To understand the historical information about the shipwreck
- To interpret the significance of shipwrecks
- To answer key questions about shipwrecks

Activity Steps

- Research a selected ancient shipwreck
- Answer key questions about the shipwreck
- Write a report using the research

Key Words

- Ancient shipwreck
- Archaeology
- Marine
- Exploring
Maritime Archaeology

Background

Archaeology is the study of the ancient and recent past through material culture, a subfield of anthropology, the study of all human culture, archaeology provides new perspectives on human history and culture. Furthermore, archaeology helps understand where and when people lived, as well as why and how they did so. Much of history relies on written records and documents to interpret the past. However, the archaeology allows us to go back in time even before written language. By analyzing objects left behind, we are able to glimpse into the past.

Underwater, maritime, or naval archaeology is necessary to describe and conduct undersea exploration. Although each discipline is slightly different from the others, all are concerned with human interactions with the sea. Research includes the study of physical remains, including underwater archaeological sites, including sunken ships, vessels, and other artifacts.

Most people think of shipwrecks when they think of maritime archaeology. In fact, today, maritime archaeologists study all aspects of the heritage, including shipwrecks, sunken cities, and underwater landscapes.

Learning Objectives

- To compare and contrast terrestrial and maritime archaeology.
- To explain the importance of maritime archaeology.
- To summarize and write succinctly.

Vocabulary

See Vocabulary Box

National Standards:

- NCSS.H.4.1 and 4; NCSS.H.7, 8, and 4; CCSS.ELA.LIT.R.1, NS.5-8.F

Who's Who in Maritime Archaeology

Background

With over three million shipwrecks resting on the world's seabed, much of human history lies hidden beneath the water. Until the 1960s, shipwrecks were inaccessible to archaeologists. SCUBA diving was only developed in the 1960s but has since been used for commercial and recreational activities. Archaeologists dove to professional divers for information about a shipwreck. However, because professional divers were not trained in archaeology, they were often not counted as reliably.

Bass started out as an English major at Johns Hopkins University, while spending his sophomore year in England at the University of Exeter, he was convinced of his potential for an art history career. With nowhere to go, he went to Sicily with some friends for spring break, and there among the Roman theater with Mount Etna in the background, he thought about how great it would be to earn a living as a terrestrial archaeologist studying ancient cultures.

Bass first began to realize that much could be learned from the many shipwrecks lying on the sea floor, and shipwrecks had advantages over terrestrial sites—artifacts were not easily discovered by humans. In the 1960s, Bass began to apply rigorous excavation techniques to underwater wrecks. Along the way, he transformed underwater archaeology from an amateur's pursuit to a modern scientific discipline.

Other early pioneers, such as Peter Throckmorton, who is often described as the "Father of Underwater Archaeology," helped to develop maritime archaeology into the discipline it is today. These early leaders led the way for the many secrets held beneath the waves to finally be revealed offering valuable insight into past cultures.

Activity Overview

In this activity, students will explore some of the great maritime archaeologists and shipwreck explorers of the 20th and 21st centuries. Using their research, students will create a bio-historical and acoustic poem and generate a storyboard. From their storyboard, students will create, produce, and present the biographical information they have learned using digital stories, PowerPoint, or other software.

http://monitor.noaa.gov
Section D

Searching the Deep — Plotting the Course

Activity A

Battle of the Atlantic

Although World War II’s Battle of the Atlantic has been extensively studied, it remains a fascinating subject. The story of the U-boat fleet that operated in this area is well documented. In fact, a network of U-boats, known as the “Wolfpack,” controlled the shipping lanes and harassed Allied merchant ships.

This section explains the tactics used by the U-boats and the efforts made by the Allies to counter them. The information is presented through a series of maps and diagrams that illustrate the key events of the battle.

Grade Level:
- 6-12

Timeframe:
- 1-2 hours

Materials per Group:
- Activity Sheet: Plotting the Course
- Colored pencils
- Copy of Convoy KS-520
- Two copies of map

Activity Summary:
This activity simulates the first stage of searching for a lost warship—research. Students conduct research to narrow the search area of an underwater battlefield. The research involves the use of historical documents, maps, and other resources to create a detailed map of the area.

Learning Objectives:
- Discover how modern technology is used to search for lost warships
- Learn about the tactics used by the U-boats

Key Words:
- Convoy KS-520
- U-boat
- Wolfpack

National Standards:
- NCTM: M1, M2, and M3
- NDE: W1, W2, and W3

Searching the Deep — Sonar Imaging

Activity B

Side Scan Sonar

Side scan sonar is a specialized system that detects objects on the seafloor. It is particularly useful for “sound navigation and ranging” (SNAV). Thus, sonar waves are transmitted into the water and reflected back to the sonar, which can then be used to create a detailed map of the area.

This section explains the basics of side scan sonar and how it is used to map the seafloor. The information is presented through a series of diagrams and photographs that illustrate the key processes of side scan sonar.

Grade Level:
- 6-12

Timeframe:
- 1-2 hours

Materials per Group:
- Prepared box—See Teacher Prep Section
- Masking tape
- Different colored pencils
- Graph paper (optional)
- Wooden skewer (~ 30 cm)

Activity Summary:
Students will simulate how side scan sonar works. They will use a coordinate grid system to map a simulated seafloor and learn about the principles of side scan sonar.

Learning Objectives:
- Use a coordinate grid system to map a simulated seafloor
- To have an understanding of how side scan sonar works
- To learn how side scan sonar is used to locate shipwrecks
- To make inferences about the topography of an unknown and inanimate landscape

Key Words:
- Echo sounder
- Side scan sonar

National Standards:
- NCTM: M1, M2, and M3
- NDE: W1, W2, and W3

http://monitor.noaa.gov
Section D
Continued

Searching the Deep — Roving Along

Searching the Deep—Magnetometers

Activity E

SCUBA, SCUBA, SCUBA — DO!

Searching the Deep — NOAA Vessels

Activity E

NOAA Vessels

NOAA ships and aircraft play a critical role in the collection of oceanographic, atmospheric, hydrographic, and fisheries data. The NOAA fleet is managed and operated by the Office of Marine and Aviation Operations (OMAO), an office composed of civilians and officers of the NOAA Commissioned Corps. OMAO also manages the NOAA Diving Program and the NOAA Small Boat Program.

OMAO's research and survey ships comprise the largest fleet of federal research ships in the nation. The fleet ranges from large oceanographic research vessels capable of exploring the world's deepest oceans, to smaller ships responsible for charting the shallow bays and inlets of the United States. The fleet supports a wide range of marine activities including fisheries research, nautical charting, and ocean and climate studies.

OMAO's aircraft operate throughout the world to perform a wide range of services including hurricane reconnaissance and research, marine mammal and fisheries assessment, and coastal mapping. NOAA aircraft carry scientists and specialized instrument packages to conduct research for NOAA's missions.

In addition to research and monitoring activities critical to NOAA's mission, OMAO ships and aircraft provide immediate response assistance for unpredictable events. Following Hurricanes Katrina and Rita, NOAA ships conducted emergency surveys for navigation hazards that helped Gulf ports reopen quickly. Aerial images of disaster-impacted areas—taken by NOAA aircraft—enabled residents and emergency workers to verify the condition of homes, bridges, and roads.

Section E

I Can Name that Part

Background
Every profession has its own terminology and jargon, and calling is no exception.

Putting the Pieces Together—Photomosaics

Background Information
How do maritime archaeologists study shipwrecks? To observe a site, they carefully document the shipwreck's shape and measurements, and create drawings and maps. When archaeologists make a careful site plan, they create a photomosaic. Photomosaics are created by taking pictures of the site and then putting them together. Photomosaics are very useful in archiving and protecting the site, as they provide a detailed record of the site.

Sometimes when a shipwreck is discovered, the archaeologists cannot spend a long time on the site. They use a technique called Photomosaics to capture an image of the site. The technique involves taking a series of photographs from different angles and then combining them to create a single, continuous image.

Mock Shipwreck: Mapping the Past

Background
During World War II, many battles were fought on foreign shores. However, few people know about those fought on foreign shores. The Battle of the Atlantic consisted of several skirmishes and decisive maneuvers between German submarines and Allied merchant ships along the coast of the Atlantic Ocean, including the United States.

The German U-boats were being used to prevent merchant vessels from reaching Allied nations. The United States deployed their own ships to act as defensive escorts armed with anti-submarine weapons. Many German and Allied merchant ships fought and sank off the North Carolina and Virginia coasts.

The wrecks of these sunk ships still lie at the bottom of the ocean. It is the job of maritime archaeologists to study and document these sites. The job of maritime archaeologists is to find and study these sites to our past in order to better understand our history, conserve our heritage, and honor the memory of those who died defending our nation's future.

To better understand these cultural resources, maritime archaeologists document them by physically mapping the shipwrecks. Once the shipwreck is mapped, a site plan is created. During the dives, numerous images are taken to enhance the detail of the site plan and to provide a complete photo documentation of the site. This thorough documentation provides researchers with a complete snapshot of the shipwreck at that moment in time, thus allowing them to study the site, learn about its history, and even gather information on how shipwrecks deteriorate over time.

Activity Summary
Maritime archaeology is a field of study that provides many career opportunities based in science, technology, engineering, and mathematics (STEM). The focus of this lesson is the creation of a shipwreck site plan. The students engage in teamwork as “divers” to create sectional, scaled drawings of a mock shipwreck. The students make connections to maritime history, mathematics, and technology.

Key Words
Extension activities incorporate English language and social studies.
Historically Significant

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Grade Level
6-12

Timeframe
1-2 hours

Materials
- Computer with internet access or
- Printed resources for students to use in researching the National Register

Activity Summary
In this lesson, students will explore the National Register of Historic Places focusing on the nomination process of vessels. Students learn the complex process of determining if a vessel is historically significant.

Learning Objectives
- To identify various criteria required for a vessel to be classified as historically significant
- To use knowledge of materials and craftsmanship to construct a fictitious nomination for the National Register.
- To analyze nominations based on criteria learned.

Vocabulary
See Vocabulary Box

National Standards:
NCSS.8, NCSS.H-T.1 and 3, CSS.ELA.LIT.R14, NOTE.1, 5, and 6, 8, and 7

Ethically Speaking

The Art of Artifacts

Grade Level
6-12

Timeframe
1-2 hours

Materials
- Computer with internet access or
- Printed resources

Activity Summary
Students answer an overarching question: Do divers have the right to take artifacts from shipwrecks? They will explore how and why military artifacts are protected and engage in a Socratic Seminar.

Learning Objectives
- To understand that shipwrecks offer a window into the past and should not be disturbed
- To learn about the Stolen Military Craft Act and other protections for cultural resources.
- To debate using a Socratic Seminar.

Vocabulary
See Vocabulary Box

Conservation and Conservators

Background
When planning to recover artifacts from a marine archaeological site, two of the most important items to consider are: 1) how to preserve the artifact and 2) how much it will cost (and who is funding it). Without conservation, most artifacts would perish and all historical information would be lost. Conservation may seem like a straightforward and simple process, but it is very complicated. Conservation is also time consuming and expensive, often costing more than the original recovery of an artifact.

Conservation does not simply involve a single set of procedures; therefore, only highly trained professional conservators should work to conserve artifacts. Moreover, professional conservators are often the first person to see an actual artifact, and for that reason, they are deeply concerned with the integrity of the artifact and the history it represents.

Conservators take on the same responsibilities as an archaeologist, and they also fill the roles of a museographer, curator, and recorder of the artifacts they conserve. They take great care to handle the artifact with respect and ensure that the artifact is conserved properly. Additionally, conservators are guided by a set of ethical guidelines adopted by the International Institute for Conservation.

When artifacts are recovered from a saltwater environment, they must be allowed to dry. Artifacts absorb salt from the water and over time, these salts become embedded in an artifact, especially in iron objects. The presence of salt can be fatal for an artifact, because as the artifact dries, salt comes out of solution and crystallizes. Salt crystals act as tiny wedges breaking apart an artifact. Therefore, before an artifact can dry, the salt must be removed. The salt removal process varies in length. Many other factors can also affect the length of time it takes to conserve an artifact, such as its size and source material.

Removing salt from objects can take years or even decades, like with the USS Monitor's turret. The process requires that skilled professional conservators and other support staff are hired. A facility must be acquired and then, there are numerous other costs, such as utilities, supplies, chemicals and more. Therefore, funding is a key component in recovering artifacts from a shipwreck.
**Historical Inventors and Divers**

**Pioneers of Diving**
- John Smollett (1724-1750) airpump
- Sieur Perrin (1760) recycled air
- William James (1800) tent bag
- Henri Laurens (1858-1859) and Auguste Denayrouze (1857-1859) rigid diving suit
- Henry Foss (1831-1832) closed circuit breathing
- Victor Hess (1913-1924) helium diving
- Emil Dohm (1906-1937) invention of demand regulator
- Philippe Tailliez (1905-1962) vinyl and rubber diving
- Paul Dicke (1908-1977) underwater photography
- Teresol Tesei (1919-1941) inventor of human amphibian
- Jacques-Yves Cousteau (1914-1997) inventor of scuba diving device & deep diving perfection needed
- James F. Carlin (1929-2008) scuba diving
- Nick Irving (1936-2013) scuba & rebreathers
- Robert Nairn (1933-1984) first Aquanaut
- Gary Gentile (1948) first scuba
- E. Lee Spence (1947) underwater photography
- George Elsey (1948-1954) closed circuit diving
- Bert Gilmore (1950) technical diving
- Bill Murphy (1952) harpoon diving
- Wesley C. Stoff (1950-1951) coral diving
- Jarno Jääskeläinen (1969) technical diving
- Claudio Fedrigo: diving movies, disturbing
- Tom Mount technical diving

**Record Holders for Depth or Cave Penetration**

- Simon Mitchell
- Claudia Serpent
- Jan Broxden (diver)
- John Bennett (dive 1959-2004)
- Mark Byl
- Norman Gomes (dive 1951)
- Passati Emanuele

**Notable for Others**
- Greg B. Ooster (1945) Aquanaut
- George F. Bass (1921) Early underwater archaeologist
- James Tallichet: Aquanaut
- Nora Berman Aquanaut
- Dominic Landl: Aquanaut
- Tony Smith (1907-2005) Aquanaut
- Karen Holmstrom Aquanaut
- Lionel Schlepp
- Carl Frankin (1953) First African American US Navy Diver
- Michael C. Ennett
- William Franklin Sr. (1924-2009)
- Aynes Mowat (1981-2011)
- Bob Harrison (1914)
- David Shaw (1955-2005)
- Dean Dyer (1915-1994)
- J. William McCollum (1970)
- Keith Jessee (1933-2010)
- Leigh Brink (1958)
- Stephen Schenk (1957)
- Steve Lewis (diver)
- Terri Jackson (dive 1985)
- Billy Dean (dive)
- Patricia Guest (1967)
- Graham Jessop (1957)
- John Chatham (1957)
- Jean-Michel Cousteau (1934)
- Ric Hohn
- Oscar Guyen (1910)
- Philippe Cousteau (1940-1978)

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**The People of SCUBA**

**Class Activity**

**Vocabulary**
- scientific diving: diving performed as a necessary part
Lesson Plans, Activities and More!
When Johnny Comes Marching Home

Background Information
Music could be heard throughout the Civil War amongst soldiers, sailors, slaves, women, men, and children. Many of the songs were taken from print, memory, or passed down orally and were sung because they were familiar songs that brought comfort or inspiration. New lyrics were often created to embellish traditional songs and the words were pertinent to circumstance or motivation.

Some songs originated as African-American spiritual songs. Slaves and workers in the fields often sang spiritual songs to bring courage, strength, and unity to the unkind conditions in which they lived and worked. Spiritual songs were usually composed in the moment, reflecting suffering or understanding.

Shanties were work songs set to a tempo that synchronized to repetitive tasks. Sea shanties, such as Blow the Man Down, also brought men together who worked on the ships at sea. The songs had a purpose and the lyrics harmonized with the sailors’ labors. There were also patriotic battle songs that inspired and unified the troops. Sailors and soldiers had songs about the flag and love of country, their sweethearts, religion, and even drinking songs. Music offered a time for the soldier and sailor to relax and reflect.

Women, children, and the men who did not go to war, also sang songs that revealed their suffering and hope for an end to the war. Civil War songs span from spiritual and protest to historical, shanty, and traditional. Action songs roused people to raise their voices. Traditional songs and ballads spoke of heritage and remembrance.

Today, songs usually are sung for entertainment. However, some still serve the purpose to pass down oral traditions, show love of country, pay tribute to the struggles of ancestors, or to protest in order to rally people to action.
The Civil War in Review

Test Your USS Monitor Knowledge

Tour the Wreck of the USS Monitor
Learning Modules

Mock Shipwreck: Mapping the Past

Activity Summary

Maritime archaeology is a field of study that provides many career opportunities based in science, technology, engineering, and mathematics (STEM). The focus of this lesson is the creation of a shipwreck site plan. The students engage in teamwork as “divers” to create sectional, scaled drawings of a mock shipwreck. The students make connections to maritime history, mathematics, and technology.

NOTE: Extension activities incorporate English language and social studies.

Learning Objectives

Students will be able to:

- Define maritime archaeology and describe its importance to our national maritime heritage.
- Employ measuring and scaling techniques to sketch drawings of a mock shipwreck to better understand how divers document an actual shipwreck.
- Determine the scale factor of their drawing in relation to the mock shipwreck.
- Make inferences about the mock shipwreck.

Background Information

During World War II, many battles were fought. Few people know about those fought in the Atlantic. During World War II, many battles were fought. Few people know about those fought in the Atlantic. During World War II, many battles were fought. Few people know about those fought in the Atlantic.

Key Words

- Maritime Archaeology
- Site Plan
- Blueprint
- Scale Factor

Materials

- Mock shipwreck top/bottom
- Tape (scotch/duct)
- Meter/feet measuring tape
- Ruler
- Water bottles
- Crayons
- Erasers
- Whiteboard markers
- Model ship
- Small containers
- Popcorn boxes
- Rulers
- Paper

Teacher Page

http://sanctuaries.noaa.gov/education

http://sanctuaries.noaa.gov/education
Shipwrecks as Reefs: Biological Surveys

**Teacher Page**

Sample Layout of Transect Lines and Quadrants:

- **Benthic**
- **Fish**
- **Genetic**

**Survey Log – Transect Line**

**Fish Species**

- **Almaco Jack**
- **Black Sea Bass**
- **Red Snapper**
- **Sheephead**
- **Tomtate**
- **Vermillion Snapper**
- **Sand Tiger Shark**

**Analyzing Your Data**

Part 1

Now that you made observations and collected data, what do you do? In order to draw conclusions or make inferences about the environment, scientists must be able to analyze data they have collected. Follow the steps below using the species count data you have collected:

1. Create graphs for the Transect Line – Fish Counts
   a. Title each according to the shipwreck surveyed
   b. Label the x-axis and y-axis
   c. Draw bars based on your fish counts

2. Compare the shipwrecks:

<table>
<thead>
<tr>
<th>Shipwreck</th>
<th>Total Number of Fish</th>
<th>Total Number of Species</th>
<th>Most Common Species</th>
<th>Least Common Species</th>
<th>Species present at both wrecks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM Clerk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Done Arrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
World War I

In or Out? Debating Entrance into the Great War

The Mystery of the Mirlô: Interpreting Primary Sources

Propaganda: Posters with a Purpose

Activity Summary
This lesson will require students to examine and evaluate propaganda posters used during World War I. At the conclusion of the activity, students will create their own poster which will require the students to demonstrate an understanding of the reasons the United States entered the war.

Learning Objectives
Students will be able to:
- Analyze propaganda posters for bias and symbolism.
- Explain and illustrate the reasons for the United States joining the Allied Powers in the First World War.
- Create an original propaganda poster.
- Evaluate other students' posters and explain which posters are the most persuasive.

Grade Level
6-12

Timeframe
90 Minutes

Materials
- Colored pencils, markers and poster board.
- Large print out or an AV projector to display posters for entire class to view and analyze.
- A computer or a computer lab is necessary to access images and resources online.
- Poster-making materials may include paper, scissors,胶水, or tape.

Life during the War: My Scrapbook

WWI Profiles: Historical Voices in Modern Technology

Zimmerman Telegram: The Last Straw

Activity Summary
This lesson focuses on the importance of the Zimmerman Telegram and other causes of World War I. Students are given a portion of the Zimmerman Telegram and must break the code and analyze the message. They are asked to think critically to determine how Americans and key decision makers, who wanted to be neutral in the European war, would feel about the telegram. Finally, they will make their own short code on how to avoid another world war.

Learning Objectives
Students will be able to:
- Examine the causes of U.S. involvement in World War I.
- Demonstrate the value in military intelligence practices, such as code breaking.

Key Words
- Zimmerman Telegram
- World War I
- Diplomacy
- Alliance
- Neutrality
Welcome to the Outer Banks Maritime Heritage Trail. Click the arrow buttons on the map to play the videos and click '+' or '-' below for descriptions of each video.

Coastal North Carolina is an extraordinary place with strong ties to the marine environment. Surrounded by water, the Outer Banks of North Carolina are a chain of narrow barrier islands separating the Currituck, Albemarle, and Pamlico Sounds from the Atlantic Ocean. This dynamic environment has shaped the islands and its people for centuries.

Along Highway 12 are a series of iconic places and features that make the Outer Banks unique. From the lighthouses to the wildlife to the shipwrecks offshore, the Outer Banks' culture reflects the surrounding marine environment. We invite you to take a trip down this stretch of road and experience the maritime heritage of the Outer Banks of North Carolina through videos, pictures, and stories.

Images

Sand tiger sharks and schools of fish are just a few of the marine organisms that can be found living on and around the shipwrecks off the coast of North Carolina. (Credit: NOAA)

Videos

- 1 Video: "Introduction" (start at Whalebone Junction)
- 3 Videos: "The Story of the Drift"
- 3 Videos: "The Biology of the Outer Banks"
- 2 Videos: "WWII and WWII off the Coast of North Carolina"
- 5 Videos: "The Chickamausa Life Savers"
- 6 Videos: "The Cape Hatteras Lighthouse"
- 6 Videos: "The story of the 111 and the 'W'"

Click here for more information about the Outer Banks.

Oral Histories

The residents of the Outer Banks have amazing stories to tell. Their lives are closely interspersed with the marine environment in which they live and their stories are as unique and diverse as their surroundings. During WWII, many residents were volunteers to the Battle of the Atlantic which occurred along the East Coast of the United States. Listen to their stories as they recall their experiences with the war that was being fought right off all their shores.

Educational Activities

Students experience the unique maritime culture of the Outer Banks, N.C., when they watch one, or all ten, video clips and listen to oral histories of those who experienced WWII on the shores of the Outer Banks. Each video is accompanied by supporting activities and a set of focus questions, to be answered while the students view the video.

Background Information

Coastal North Carolina is an extraordinary place with strong ties to the marine environment. Surrounded by water, the Outer Banks of North Carolina are a chain of narrow barrier islands separating the Currituck, Albemarle, and Pamlico Sounds from the Atlantic Ocean. This dynamic environment has shaped the islands and its people for centuries.

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Through videos, pictures, and stories, we invite you to take a trip down this stretch of road and experience the rich maritime history of the Outer Banks of North Carolina.

Activity Summary

Students experience the unique maritime culture of the Outer Banks, N.C., when they watch one, or all ten, video clips and listen to oral histories of those who experienced WWII on the shores of the Outer Banks. Each video is accompanied by a set of focus questions, to be answered while the students view the video, and other supporting activities.

Learning Objectives

Students will be able to:

- Recognize unique features of the Outer Banks, N.C.
- Understand the area’s significance during World War II
- Discover the final resting place of the USS Monitor
- Appreciate the importance of lighthouses along the coast
- Explain why this area is called The Graveyard of the Atlantic
- Learn about the rich ecology of the Outer Banks

Materials

- Internet/Computer
- Worksheet

Key Words

- Cape Hatteras
- Diversity
- Ecosystems
- Gulf Stream
- Ironclad
- Outer Banks
- Sanctuary
- Sonar
- U-boat

Teacher Prep

Download videos and/or oral histories, or bookmark website: http://monitor.noaa.gov/obxl marinetrail for students.

http://sanctuaries.noaa.gov/education
Video: The USS Monitor and NOAA: A Look Through Time

https://www.youtube.com/watch?v=EX6H3Tp-2yE

Or visit the “Teacher” Section at http://monitor.noaa.gov
To download copies of modules and activities visit:

http://monitor.noaa.gov

“Education” Tab
Monitor NMS Education Websites

http://monitor.noaa.gov/education/teachers.html

Shipwrecks and STEM

Maritime Archaeology: Discovering and Exploring Shipwrecks

This curriculum introduces students to the world of NOAA and its Maritime Heritage Program. Students learn 1) why shipwrecks are important, 2) the tools used to study shipwrecks, 3) about the complex and costly process of recovering and conserving artifacts, and 4) how NOAA works to protect our maritime heritage. Although the curriculum is designed to be taught as a unit, each lesson can stand on its own. The lessons are aligned with national standards.

Shipwreck of the Deep

The project-based curriculum is divided into three parts and based on a storyline where the students are 1) maritime archaeologists that discover and document a shipwreck, 2) engineers that design and build a remotely operated vehicle, 3) researchers that study the wreck as a reef, and 4) conservators that help to determine if artifacts should be recovered. To culminate the unit, students debate in a Socratic seminar and give a final presentation detailing their analysis of the shipwreck and recommendations. The curriculum is designed as a unit, but each activity stands on its own. The unit is aligned to national standards.

Remotely Operated Vehicle (ROV) In a Bucket

Check out this excellent manual to get you started building your own underwater robot. The manual includes a detailed list of ROV parts and pieces and where to find them. (Doug Levin, NOAA Chesapeake Bay Office).

Remotely Operated Vehicles Curriculum Guide

This curriculum introduces middle and high school students to ROVs and careers in marine science and underwater archaeology. Students use problem based learning and hands-on STEM activities to solve real world problems, while learning about the engineering design process. Curriculum can be used in its entirety or activities can be used independently.

- Teacher One-Pager
- Student One-Pager
- ROV Curriculum Guide

Mock Shipwreck: Mapping the Past

This high school activity engages students in teamwork as "divers" to create sectioned, scaled drawings of a mock shipwreck. They make connections to maritime history, mathematics, and technology.

- Lesson Guide Mock Shipwreck
- Log Sheets Port 10 Units
- Log Sheets Starboard 10 Units
- Log Sheets Port 12 Inches
- Log Sheets Starboard 12 Inches

Wrecks as Reefs
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• #MonitorMondays
• #TBT
• #WackyWednesdays
• Monitor Trivia
• This Day in History
• Current Expeditions
• And More!
Thank You!

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